COMSATS University Islamabad

Abbottabad, Pakistan

Smart Water: Smart Water Quality System Using IoT And Deep Learning

By

Zanib Hanif	**CUI/FA18-BCS-050/ATD**
Shanzay Kamran	**CUI/FA18-BCS-127/ATD**
Shakeeb Raza Ullah	**CUI/FA18-BCS-076/ATD**

Supervisor

Sir Mateen Yaqoob

Bachelor of Science in Computer Science (2018-2022)

The candidate confirms that the work submitted is their own and appropriate credit has been given where reference has been made to the work of others.

COMSATS University, Islamabad Pakistan

Smart Water: Smart Water Quality System Using IoT And Deep Learning

A project presented to

COMSATS Institute of Information Technology, Islamabad

In partial fulfillment

of the requirement for the degree of

Bachelor of Science in Computer Science (2018-2022)

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Zanib Hanif	Shanzay Kamran	Shakeeb Raza Ullah
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<u>CERTIFICATE OF APPROVAL</u>

This page is to certify that this Final Year Project (FYP) of BCS "Smart Water: Smart Water Quality System Using IoT And Deep Learning" was developed by **Zanib Hanif (CIIT/FA18-BCS-050/ATD) Shanzay Kamran (CIIT/FA18-BCS-127/ATD)** and Shakeeb **Raza Ullah (CIIT/FA18-BCS-076/ATD)** under the supervision of "**Sir Mateen Yaqoob**" and that in (their/his/her) opinion it is fully adequate, in scope and quality for the degree of Bachelor's in Computer Science.

Supervisor

External Examiner

Head of Department
(Department of Computer Science)

EXECUTIVE SUMMARY

There are many different systems available like our project, but they all have different problems i.e., using less sensors, not predicting or forecasting the water quality check, and many more. So, because of all those problems we develop a project which will utilize the internet of things (IOT), which enables real-time monitoring of water quality through use of five sensors that integrate drinking water quality measurements such as PH, temperature, turbidity, TDS, and a water flow sensor for drinking a system based on IoT and machine learning. We developed this project as a whole package. This project will contain Gathering live data from sensors, collected data transfer to firebase using Arduino and Wi-Fi -module, live readings shown on app and prediction done on collected data using machine learning algorithm.

ACKNOWLEDGEMENT

All praise is to Almighty Allah who bestowed upon us a minute portion of His boundless knowledge by virtue of which we were able to accomplish this challenging task.

We are greatly indebted to our project supervisor "**Sir Mateen Yaqoob**". Without his personal supervision, advice and valuable guidance, completion of this project would have been doubtful. We are deeply indebted to him for their encouragement and continual help during this work.

And we are also thankful to our parents and family who have been a constant source of encouragement for us and brought us the values of honesty & hard work.

Zanib Hanif	Shanzay Kamran	Shakeeb Raza Ullah
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ABBREVIATION

ABBREVIATION	FULL FORM
SWQS	Smart Water Quality System
SRS	Software Requirement Specification
FR	Function Requirement
NFR	Non-Functional Requirement
IOT	Internet Of Things
DL	Deep Learning
ML	Machine Learning
UC	Use Case
TDS	Total Dissolve Solids
PH	Potential Hydrogen
UT	Unit Testing
ST	System Testing
IT	Integration Testing

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1. Introduction

1.1. Brief

The quality of drinking water must be monitored in real time in order to ensure its safety. Our project involves the design and implementation of a low-cost system for real-time water quality monitoring in the IOT (internet of things). The system in this project consists of multiple sensors that detect various factors such as pH, turbidity in the water, TDS, water level sensor, and temperature. These sensors were interfaced with the Arduino-based NodeMCU. Then using deep learning algorithm on the data for prediction of good quality water which will be monitor on a mobile application.

The water quality system is used to determine the water's quality. The app will keep track of the various water measurements. This device will preserve the purity of water by detecting any harm or contaminants in the water and notify the user.

1.2. Relevance to Course Modules

- Machine learning (ML)
- Deep learning (DL)
- Internet of things (IOT)
- Software Engineering (SE-1)
- Mobile Application and Development (MAD)
- Software Requirement Engineering (SRE)
- Software Testing
- Software Development Life Cycle
- Software Project Management (SPM)

1.3. Project Background

The idea about the project comes from the real-world problem because there is no proper monitoring of water quality and its prediction So, because of that we decided to develop Smart Water Quality System Using IoT and Deep Learning (SWQS).

1.4. Literature Review

For the literature review we have reviewed some of the existing software and read some of the papers. As a conclusion we came to know that these other projects are not dynamic and does not fulfill the complete requirements of the market. Our project is dynamic and smoother which allows the user to use it without any hassle.

Summary of some papers are listed below:

- • "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project," by Nikhil Kedia. Printed at the 2015 Dehradun, India, First International Conference on Next Generation Computing Technologies (NGCT-2015). The complete water quality monitoring process, including the sensors, embedded design, information dissipation process, and roles of the government, network operator, and villages in guaranteeing proper information dissipation, are highlighted in this study. Additionally, the Sensor Cloud domain is explored. At this time, it is not possible to automatically enhance water quality, but effective use of technology and cost-effective business strategies can help. [1]
- "Real Time Water Quality Monitoring System," by Jayti Bhatt and Jignesh Patoliya. This

paper explains how real-time monitoring of water quality is necessary to assure the supply of safe drinking water. An innovative method based on the Internet of Things (IoT) has been suggested for this purpose. In this research, we demonstrate the architecture of an IOT-based system for real-time water quality monitoring. This system comprises of a few sensors that detect many aspects of water quality, including temperature, conductivity, dissolved oxygen, pH, and turbidity. The microcontroller processes the sensor-measured values before transmitting them over the Zigbee protocol to the raspberry pi, which serves as the core controller. Lastly, sensors data can be seen online.[2]

- "Industry 4.0 as a Part of Smart Cities," by Michal Lom, Ondrej Pribyl, and Miroslav Svitek. The intersection of the Smart City Initiative and the idea of Industry 4.0 is discussed in this essay. The term "smart city" has been quite popular over the past few years, especially since 2008, when the global financial crisis occurred. The Smart City Initiative was founded primarily to build a sustainable model for cities and protect inhabitants' quality of life. [3]

1.5. Analysis for Literature Review

There are a lot of drawbacks in existing systems, all the system are not vast they are checking less parameters of water where as our system is on five very essential parameters and, in addition to water quality monitoring this system also provides water quality prediction with a visual representation on a mobile application.

1.6. Methodology and Software Lifecyle for the Project

We will adopt the INCREMENTAL APPROCH as our software development methodology.

1.6.1. Rationale behind Selected Methodology

The initial increment is typically a basic/core product where the fundamental criteria are met and additional features are added in later increments. This is the key justification we gave for choosing the incremental method. The entire system's development will be broken up into manageable pieces, with the most crucial requirements being taken care of first. This model is less expensive, and adjustments are always possible. It is less expensive and more flexible to alter the needs and scope. All of the specifications weren't met, and they kept changing, which resulted in alterations to the final product. The phases of gathering requirements and execution operated concurrently until the project's conclusion.

2. Problem Definition

2.1. Problem Statement

In the age of information and technology medical stores are still depended on paperwork. All the billing and transection details are still on the paper. Sometime the store owner forgets to place order for medicines because there is no proper mean to notify him about the medicine shortage, and sometime es medicine providers misplace the order details. Because of this, medical stores face's problem of shortages and delay. There is no proper back traceability.

2.2. Deliverables and Development Requirements

Table 1 displays all of the deliverables and the needed development.

Table 2.1: Deliverables and Development Requirements

Specification	***Required***
Programing Languages	Flutter (dart) Arduino(c++) Ml algo(python)
Hardware Platforms	Android Phone
IDE	Vs code
Operating System	Android 6.0+ and IOS
Firebase	RTDB

3. Requirements Analysis

3.1. Use Case Diagram

Figure 1 This Diagram shows an illustration of how users interact with the system User can Login, Register, view Results on the app.

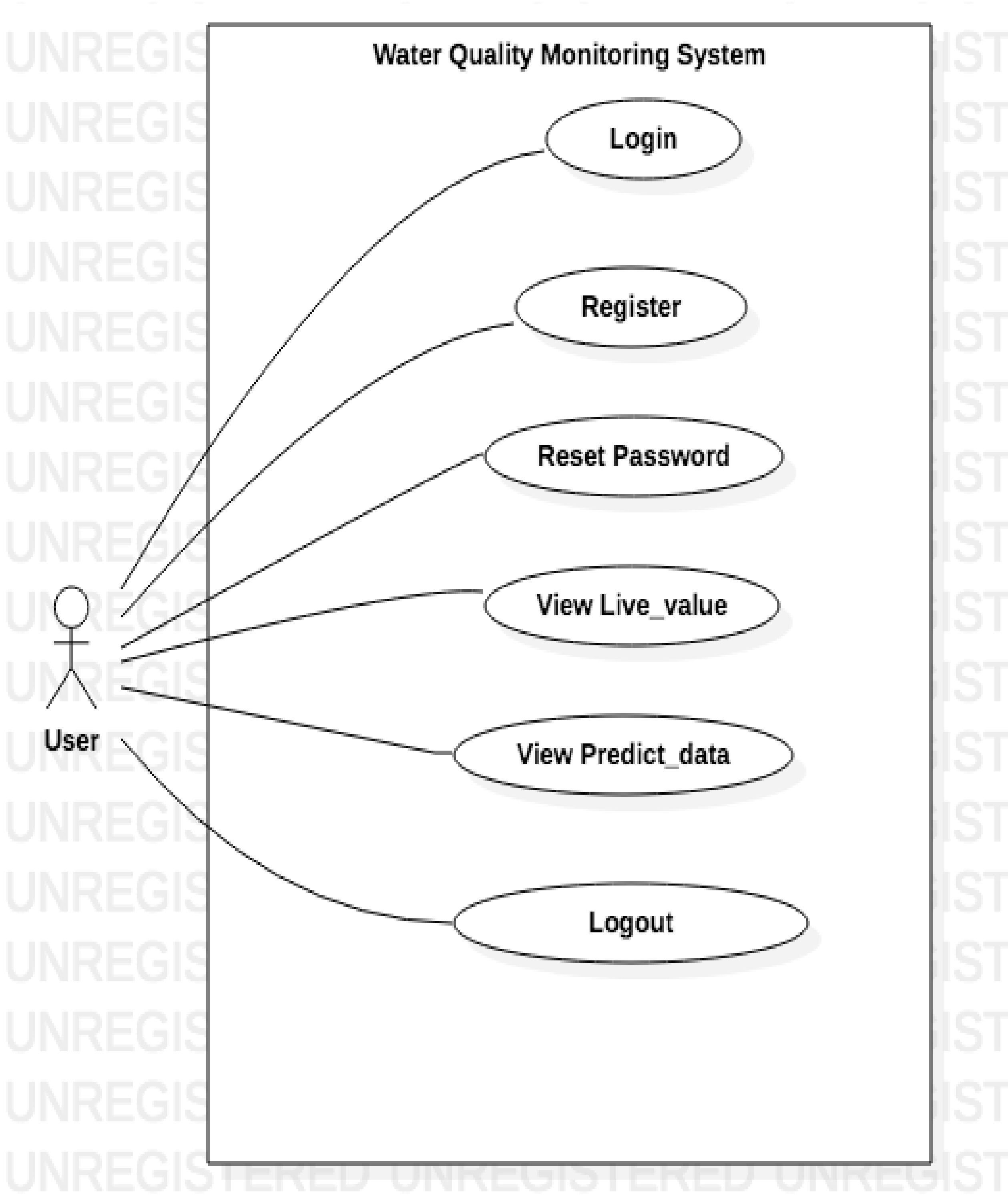

Figure 3.1: Use Case Diagram

3.2. Detail Use Cases

3.2.1. Registration

Water Quality Monitoring System, User have to fill all the formalities given in registrations page in order to access the website.

Table 3.1: Use case Register

Use Case ID:	UC-1
UseCase Name:	Register
Actors:	Primary Actor: User
Description:	Individual can register itself
Trigger:	An individual can click on registration button.
Preconditions:	PRE1- System should be ideal
Post conditions:	Individual should be able to fill the signup requirements properly.
Normal Flow:	• Type user name • User Email/Name • Password • Re-enter password • Register
Alternative Flows:	User directly enters the signup URL
Exceptions:	The two passwords are not matched.
Business Rules	Individual should be able to complete the Register form.
Assumptions:	individual is at the home page

3.2.2. Login

In water Quality Monitoring system app to use the functionalities or the facilities of app User have to login first

Table 3.2: Use case Login

Use Case ID:	UC-2
Use Case Name:	Login
Actor:	Primary Actor: User
Description:	An individual can login themselves.
Trigger:	An individual clicks the login button.
Preconditions:	PRE-1: System should be ideal.
Postconditions:	POST-1: An individual will be able to login.
Normal Flow:	1. User enters the registered email. 2. User enters the registered password. 3. User clicks on login.
Alternative Flow:	1. User directly enters the login URL in browser.
Exception:	1. User press login without providing the credentials. 2. Email incorrect. 3. Password incorrect. 4. Website Fails/Crash 5. Website display error message.
Business Rules:	BR-1 User will be able to login.
Assumptions:	User is at the login page of the website.

3.2.3. Reset Password

In Water Quality Monitoring System, User can Recover Password If Your fail to Remember the old one by entering Active Email account.

Table 3.3: Reset Password

Use Case ID:	UC-3
Use Case Name:	Reset Password
Actors:	Primary Actor: User
Description:	By entering their active email upon registration, users can reset their password.
Trigger:	Individual will click the Register button
Preconditions:	PRE1- System should be ideal
Post conditions:	User input for the accurate recovery report should be possible.
Normal Flow:	• Forget Password • Enter Active Email • Get Recovery Code
Alternative Flows:	An individual directly enters the signup URL.
Exceptions:	Your email address does not match the one on file.
Business Rules	The Register form ought to be completeable by the user.
Assumptions:	The user is on the homepage.

3.2.4. Live Data

In Water Quality Monitoring System, User can View Live values getting From the Sensors on dashboard.

Table 3.4: Live Data

Use Case ID:	UC-4
UseCase Name:	Show Live values
Actors:	Primary Actor: User
Description:	After gathering data and complete readings will be shown to the User.
Trigger:	In App user can see both live and predicted values on dashboard user can get the current live readings and after clicking on predicted values the values shown to the user
Preconditions:	PRE1- System needs to be perfect
Postconditions:	Prediction graph of calculations will be shown to the user.
Normal Flow:	On dashboard user can see both live and predicted values.
Alternative Flows:	After taking values from the sensors. User have shown the readings.
Exceptions:	Shows errors for incorrect email or password
Business Rules	Actor has an active internet connection.

3.2.5. Predicted data

In water Quality Monitoring System, User can Also View the Predicted data on the App.

Table 3.5: Predicted data

UseCase ID:	UC-5
UseCase Name:	View Predicted Data
Actors:	Secondary User: Sensor
Description:	When Live readings store in Firebase, ML algo's will be implemented for making prediction. And by that we can get the prediction of upcoming three days.
Trigger:	Connectivity between Wi-Fi-module and database Sensors should be in proper workable condition.
Preconditions:	PRE1- System should be ideal
Post conditions:	Predicted values will be shown to the user.
Normal Flow:	While applying ML algo's the prediction should be shown
Alternative Flows:	User have to see measurements.
Exceptions:	Shows errors for incorrect email or password.
Business Rules	System must follow the correct behavior without closing and showing error.

3.2.6. Show Value

In water Quality Monitoring System, User can see both type of readings Live reading (getting From sensors) and the Predicted Values (After the implementation of ML algos).

Table 3.6: Use Case Show value

Use Case ID:	UC-6
Use Case Name:	Show values
Actors:	Primary Actor: User
Description:	After gathering data and complete readings will be shown to the User.
Trigger:	In App user can see both live and predicted values on dashboard user can get the current live readings and after clicking on predicted values the values shown to the user
Preconditions:	PRE1- System should be ideal
Post conditions:	Prediction graph of calculations will be shown to the user.
Normal Flow:	On dashboard user can see both live and predicted values.
Alternative Flows:	After taking values from the sensors. User have shown the readings.
Exceptions:	Shows errors for incorrect email or password
Business Rules	Actor has an active internet connection.

3.2.7. Log Out

In water Quality Monitoring , User can logout the app whenever he wants to.

Table 3.7: Use Case Water Quality

Use Case ID:	UC-7
Use Case Name:	Logout
Actors:	Primary Actor: User
Description:	User may exit
Trigger:	An individual will select the Logout button.
Preconditions:	For login, the user must enter the proper email address and password.
Post conditions:	User must be connected properly in order to logout. Username, Email, and Logout
Normal Flow:	• User Email • Password • Logout
Alternative Flows:	User enters Sign-In URL directly
Exceptions:	Unable to logout if incorrect password or email entered.
Business Rules	User need to be able enter a working email.

3.3. Functional Requirements

Functional Requirements are:

1. Registration
2. Login
3. Change Password
4. Live Measurement
5. Prediction
6. Monitoring

3.3.1. FR-01 Registration

Registration is the functional requirement of the system. System can process user registration.

Table 3.8: FR-01 Registration

ID	**01**
Title	Registration
Requirement	• Stable internet require. • Active Email Address require.
Source	Student/user
Rationale	Mandatory and must be used at least once.
Priority	High

3.3.2. FR-02 Login

Login is the functional requirement of the system. System can validate User Login.

Table 3.9: FR-02 Login

ID	**02**
Title	Login
Requirement	• Stable internet require. • Registration is must. • Must entered Correct Username/password
Source	Student/User
Rationale	Mandatory and it must be used to avail of App Functionalities
Priority	High

3.3.3. FR-03 Reset Password

Reset Password is the functional requirement of the system. System can process user Account recovery.

Table 3.10: FR-03 Reset Password

ID	**03**
Title	Reset Password
Source	• Stable internet is required • Must entered Active email while registration so can get recovery code
Requirement	Student/user
Rationale	Mandatory and must to get your account recovered
Priority	High

3.3.4. FR-04 Live Measurement

Live Measurement is the functional requirement of the system. System can make user able to see Live Readings.

Table 3.11: FR-04 Live Measurements

ID	**04**
Title	Live Measurements
Requirement	• Stable internet require. • User must be login. • WIFI-Module connectivity is must • Sensors must be in workable condition.
Source	Student/User
Rationale	Mandatory and must be used to get Live measurements.
Priority	High

3.3.5. FR-05 Prediction

Prediction is the functional requirement of the system. System can make user able to see the prediction of water Quality.

Table 3.12: FR-05 Prediction

ID	**05**
Title	Prediction
Requirement	• Stable internet require. • User must be login. • Sensors must be in workable condition • Data must be stored in database so can apply ML Algo to get prediction of specific days.
Source	Student
Rationale	Important part of the project to get prediction.
Priority	High

3.3.6. FR-06 Monitoring

Monitoring is the functional requirement of the system. User can judge the value by getting both live and predicted value from the System.

Table 3.13: FR-06 Monitoring

ID	**06**
Title	Monitoring
Requirement	• Stable internet require. • User must be login. • Data store is must to check both live and predicted values.
Source	Student
Rationale	Important part of the project and is must so user can see both live and predicted value to check condition of water.
Priority	High

3.4. Non-Functional Requirements

The Non-Functional Requirements are listed below (NFR)

1. **NFR-1:** Performance: connection between app and WIFI is necessary
2. **NFR-2:** Availability: Hardware and environment in which it runs are functional,
3. **NFR-3:** Usability: Easy to learn and use for a novice user
4. **NFR-4:** Security and safety: The system cannot share the information of one user
   to another.
5. **NFR-5:** Flexibility: This system is flexible, as more sensors can be
   Added.

4. Design and Architecture

4.1. Package Diagram

In Water Quality Monitoring system. The client and server sides of the project are depicted in the package diagram.

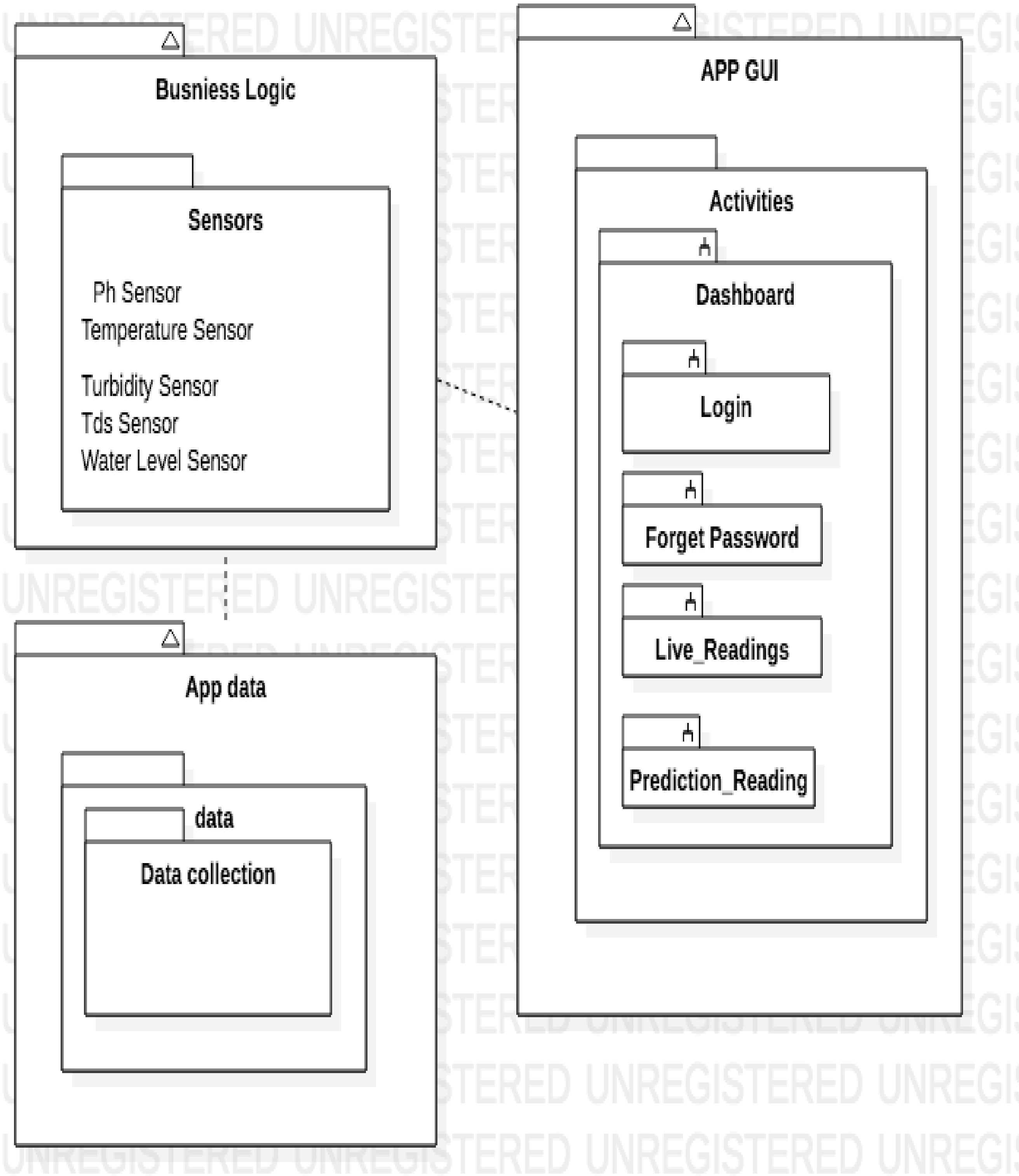

Figure 4.1: Package Diagram

4.2. Activity Diagram

In Water Quality Monitoring System, The Activity Diagram shows the flow of control in the system.

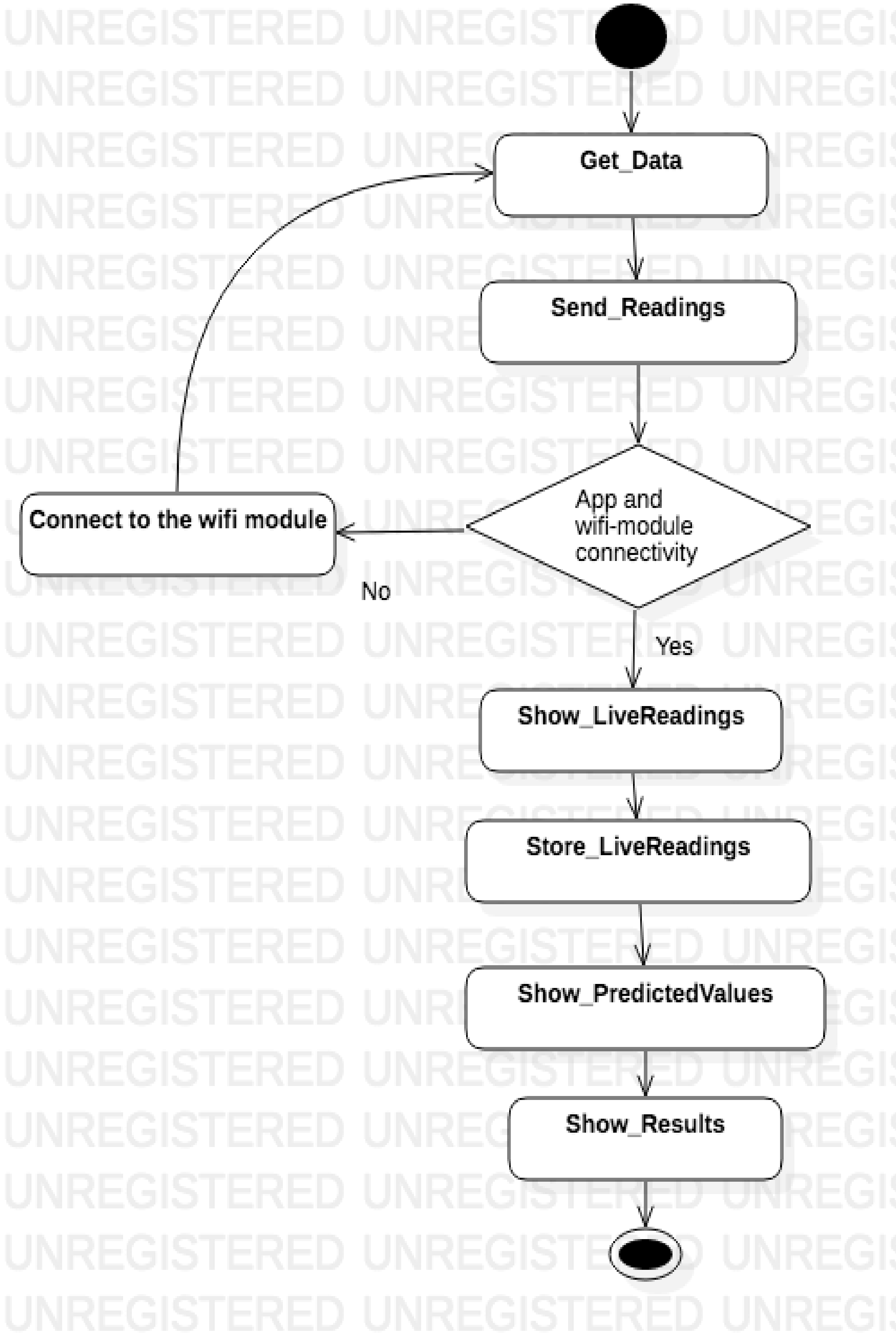

Figure4.2: Activity Diagram

4.3. Design Models

4.3.1. Iterative Model and incremental Model

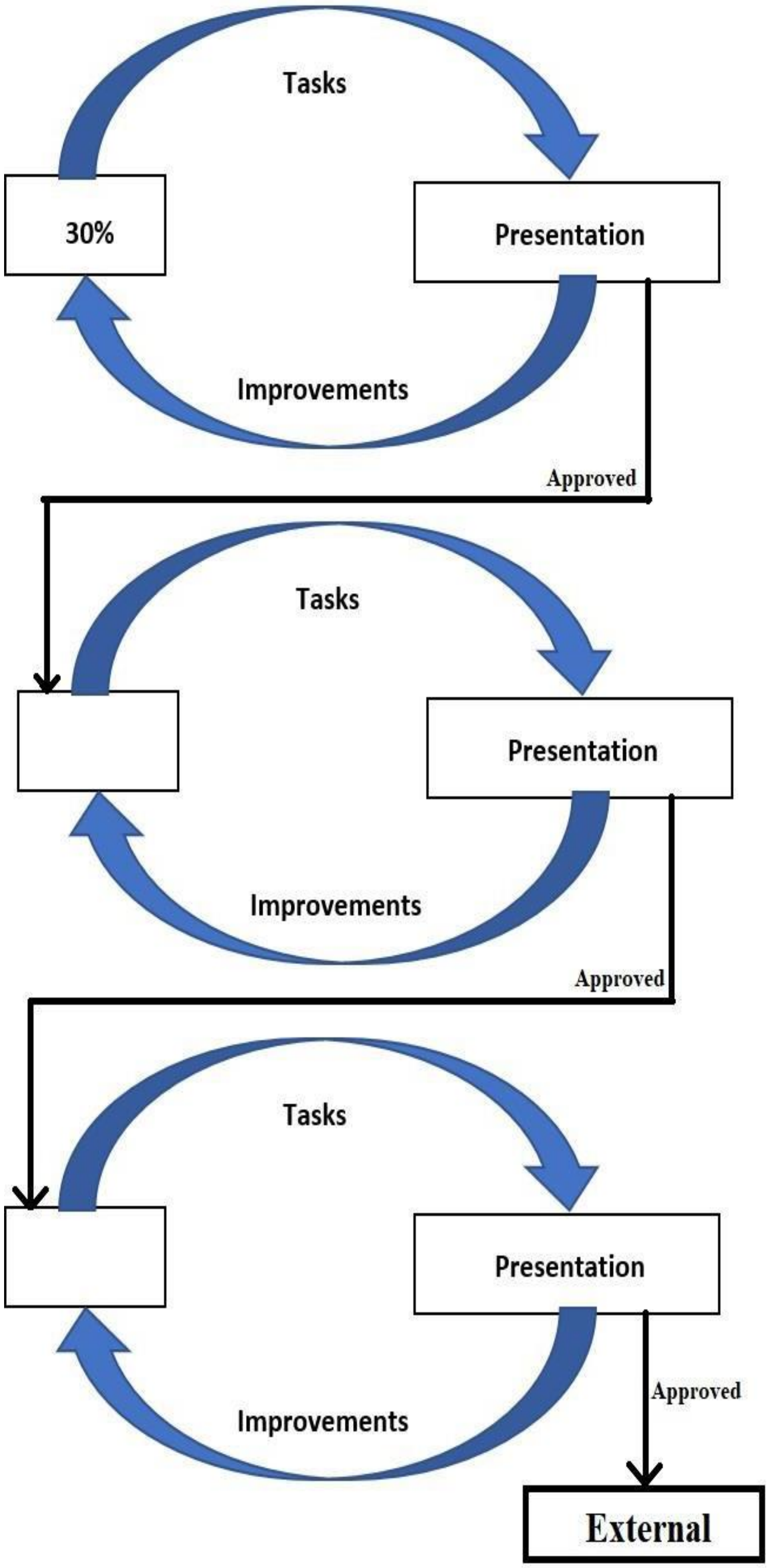

Figure 4.3: Iterative Model

4.4. Deployment Diagram

In water Quality Monitoring System , The deployment diagram shows the connectivity of hardware components with software components.

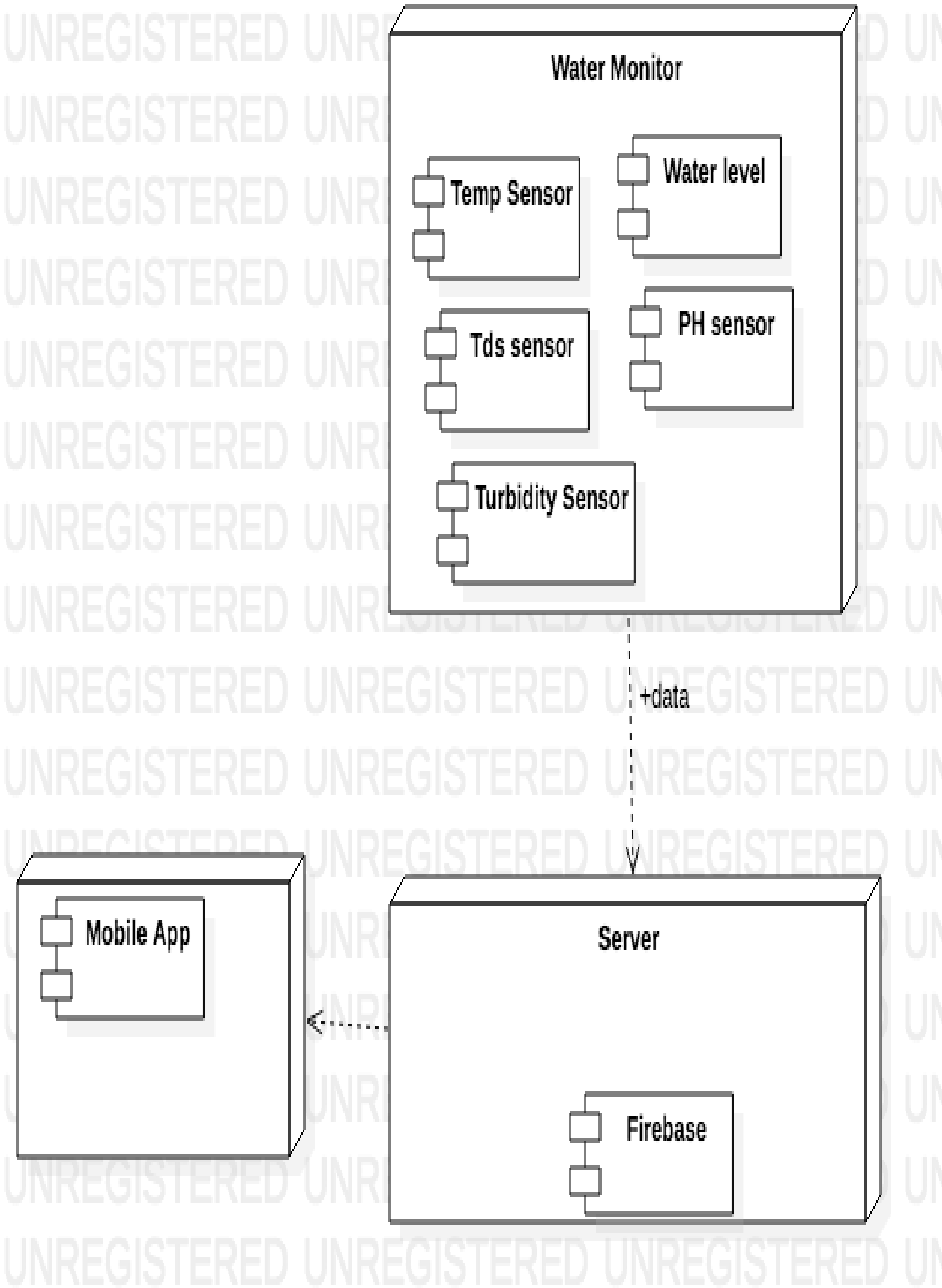

Figure 4.4: Deployment Diagram

4.5. Class Diagram

In water Quality Monitoring system, the class diagram shows the Structures of system , different classes and attributes in the system.

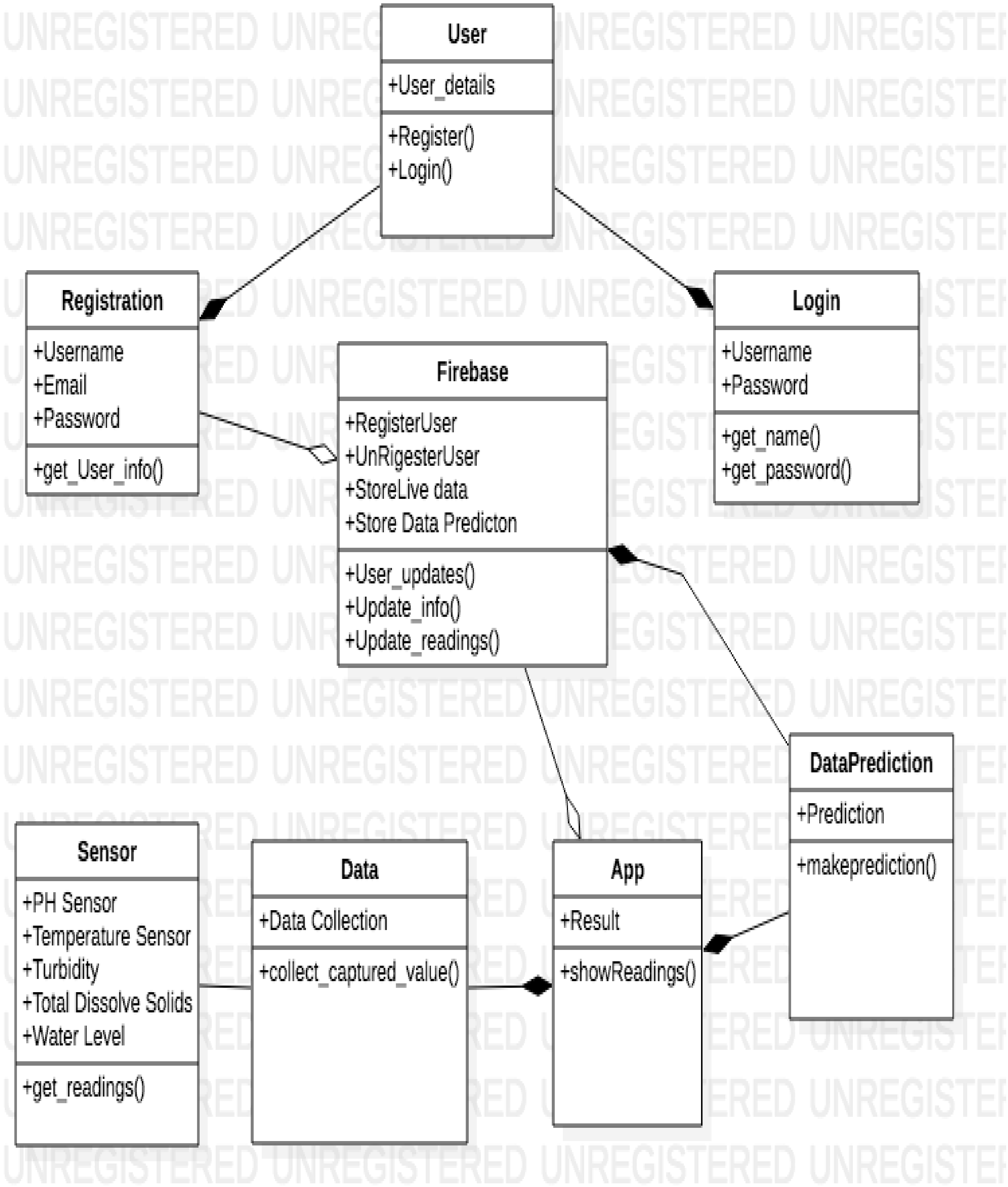

Figure 4.5: Class Diagram

4.6. Sequence Diagram

4.6.1. Data Representation

This diagram shows the sequence operation between the Sensor, Firebase, App and Data when user wants to see Live and Predicted values on app

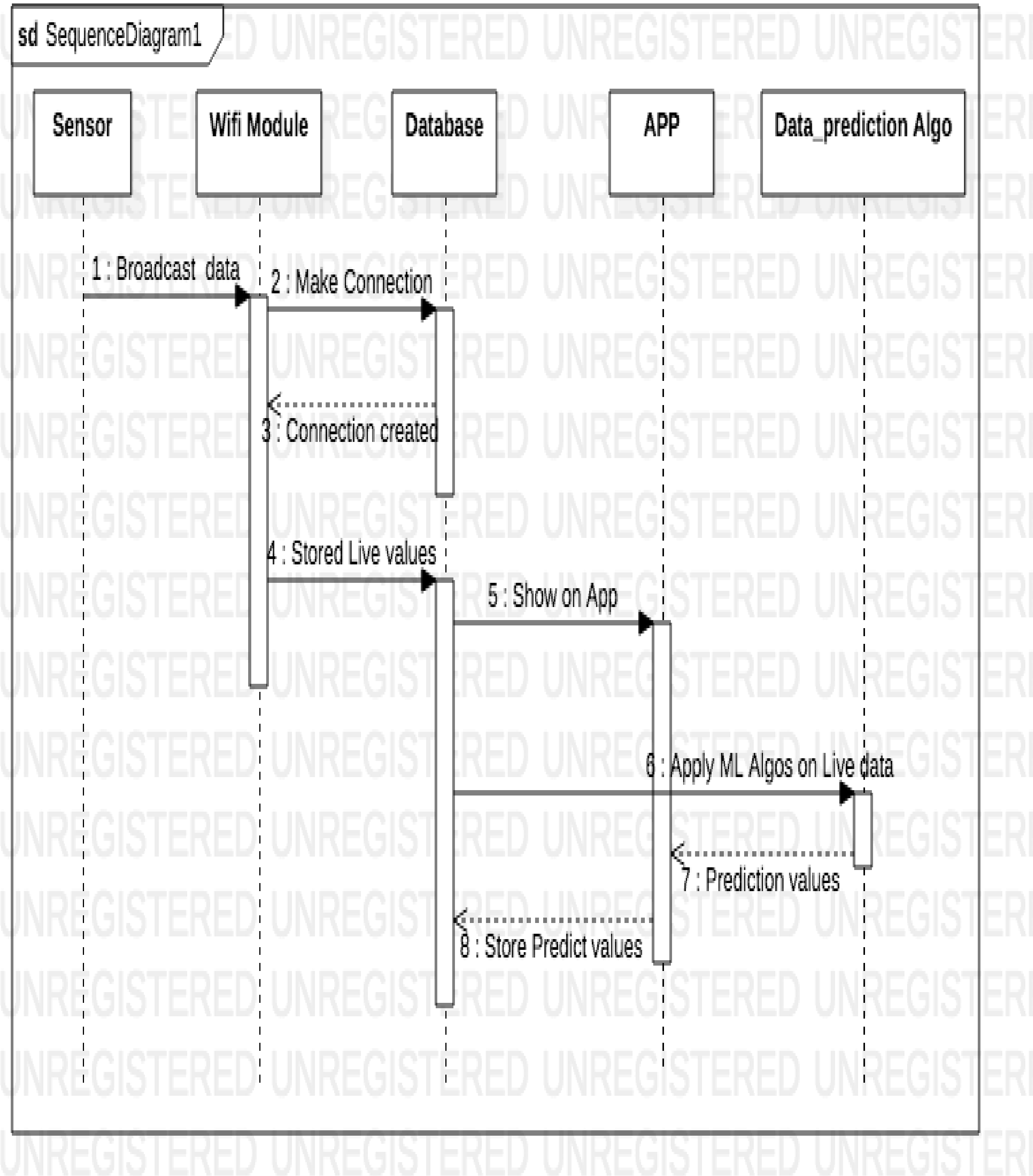

Figure 4.6: SD Data Representation

4.7. System Sequence Diagram

4.7.1. Login

This diagram shows the sequence operation between the User and the System.

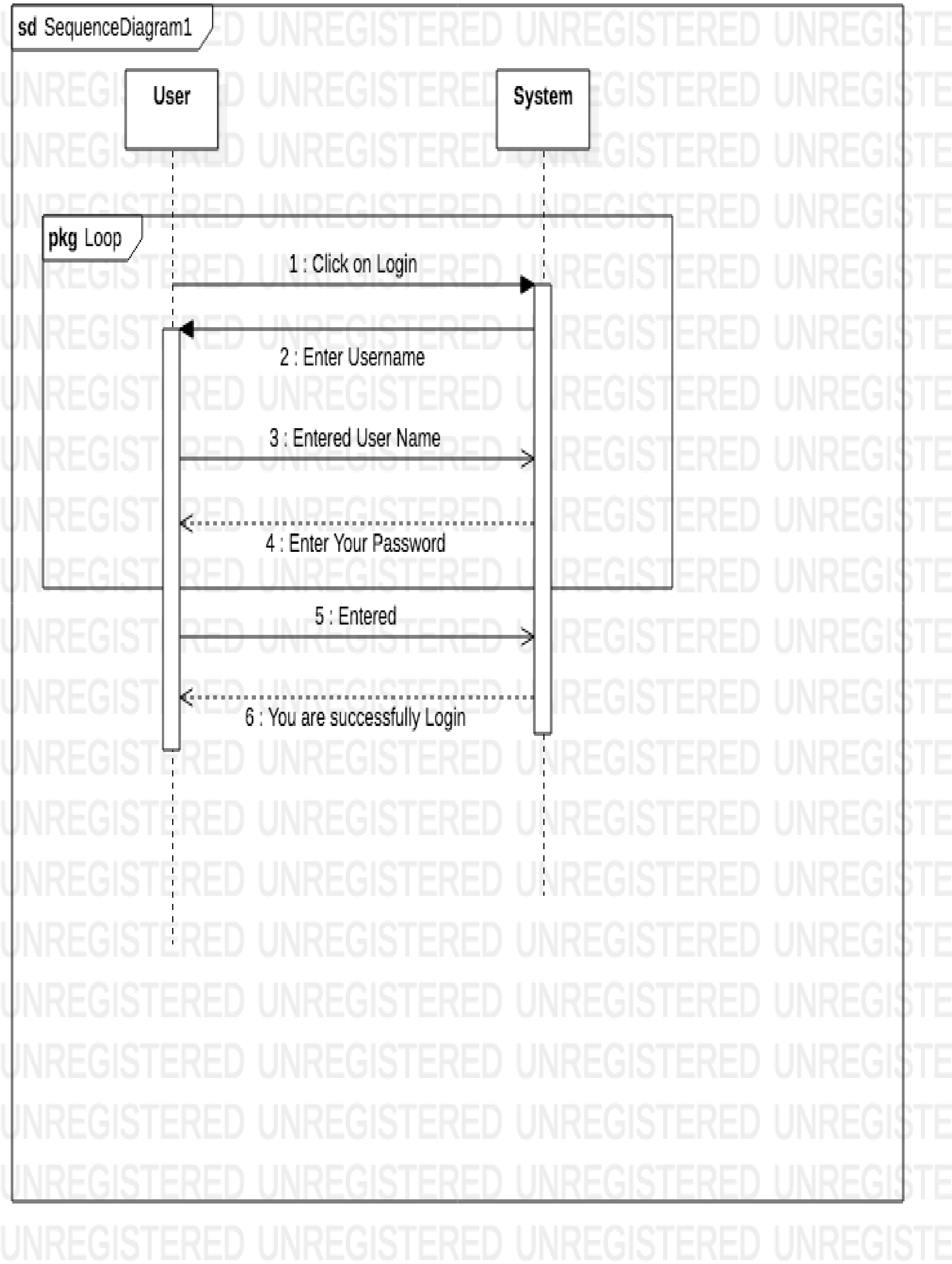

Figure 4.7: SSD Login

4.7.2. Register

This diagram shows the sequence operation between the User and the system that how user can register itself.

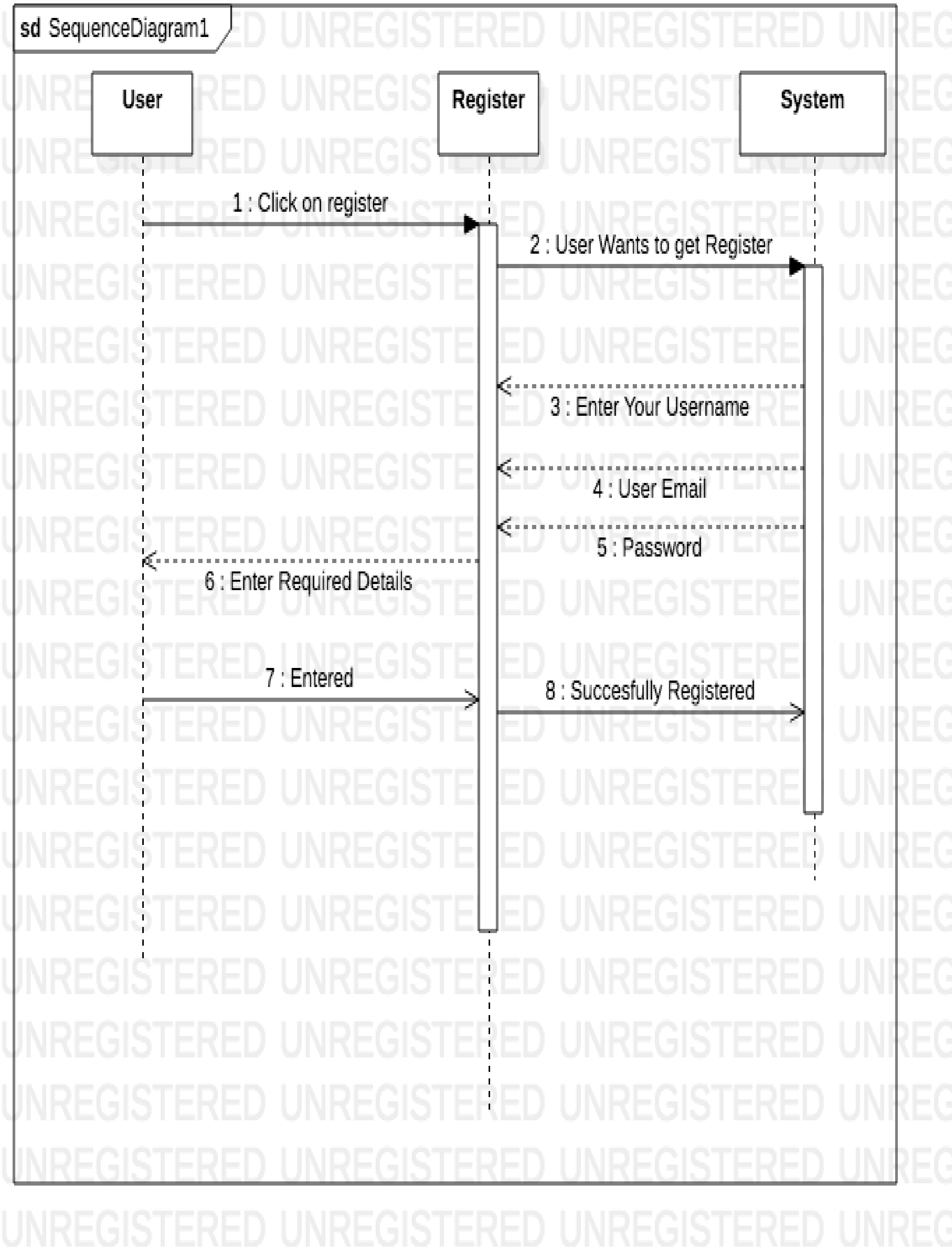

Figure 4.8: SSD Register

4.7.3. Reset Password

This diagram shows the sequence operation between the User and the System. That how user can get recovery code in order to Access the system again.

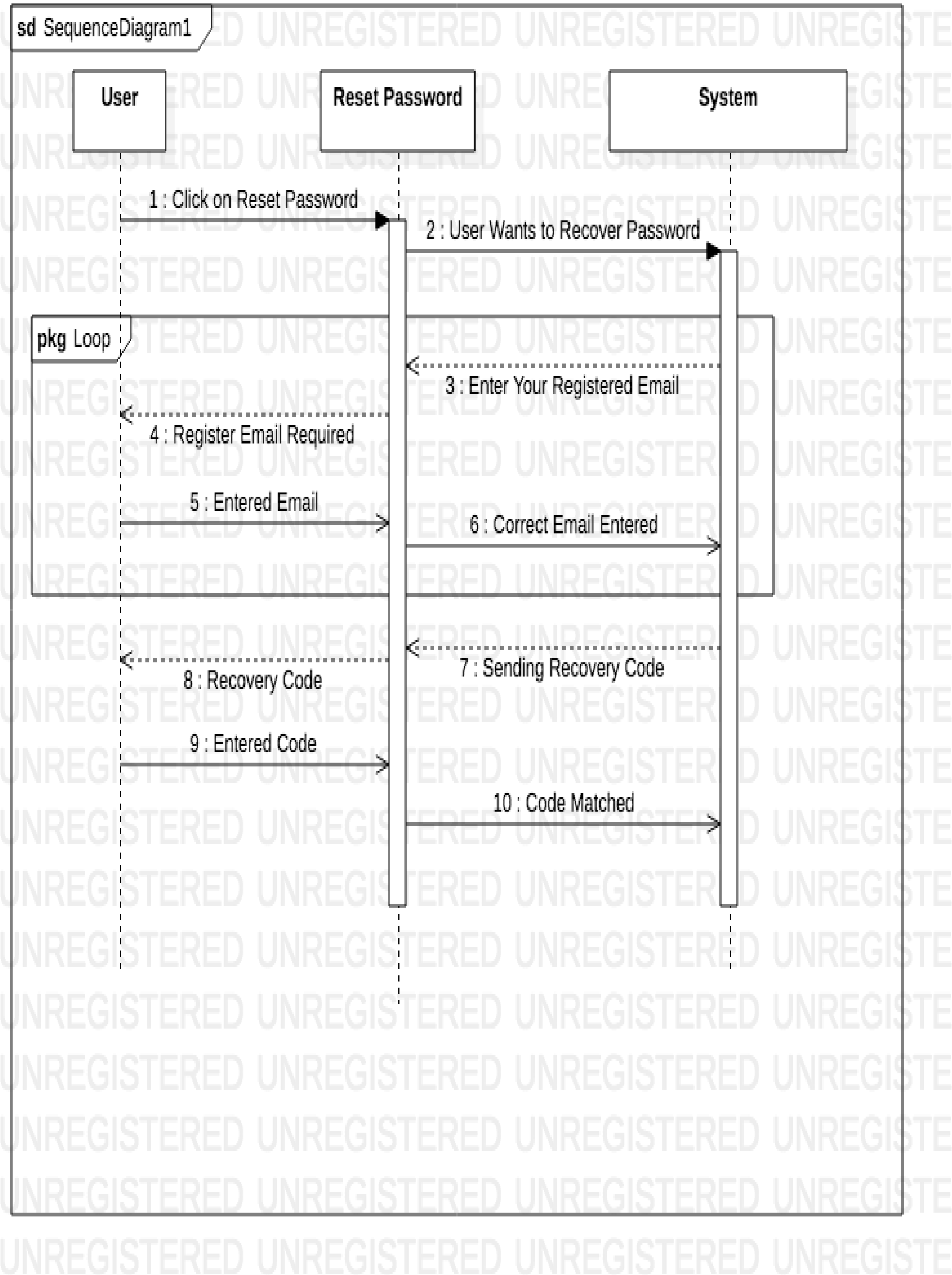

Figure 4.9: SSD Reset Password

4.7.4. Live Data

This diagram shows the sequence operation between the Sensor and the system that how user can view live data on the system.

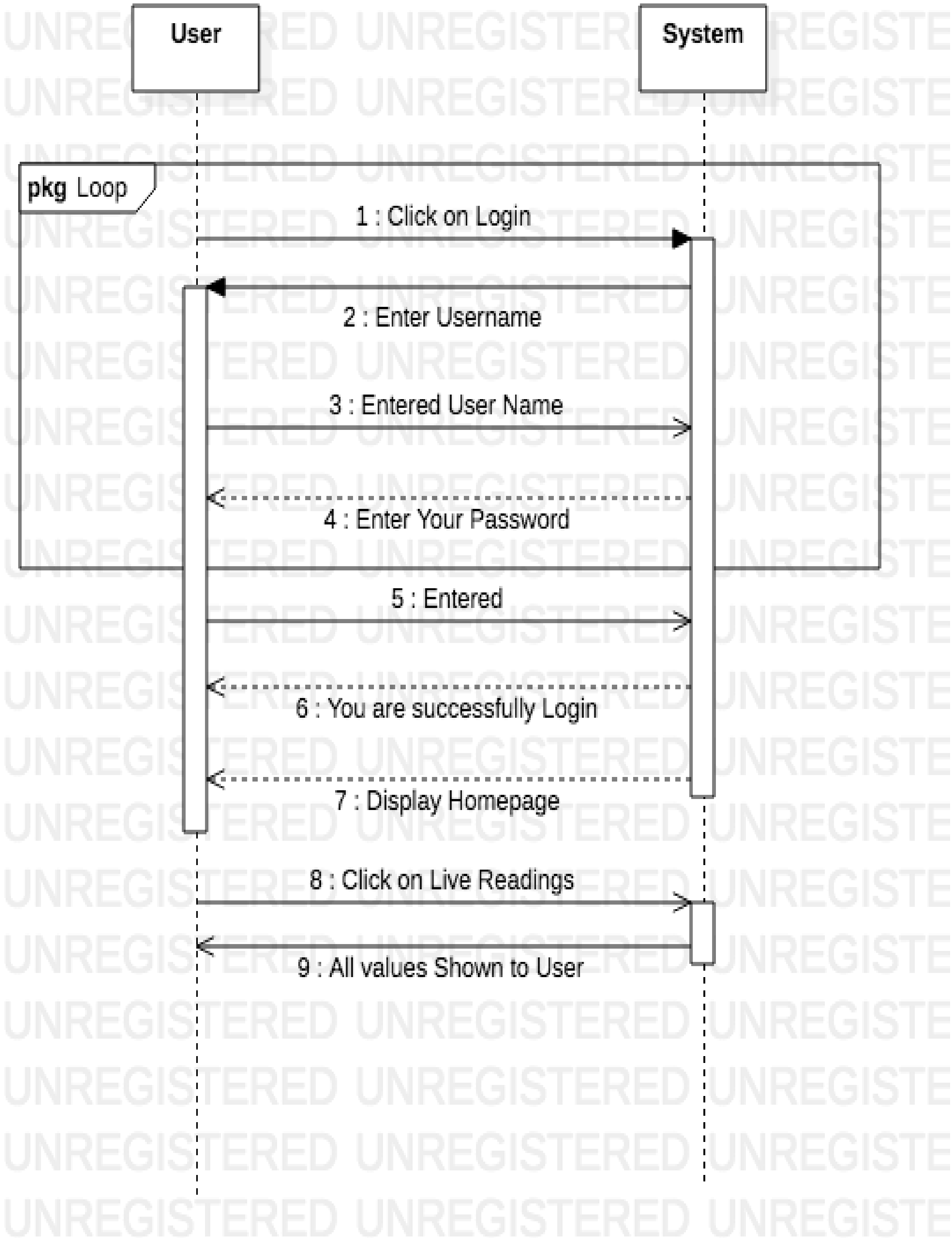

Figure 4.10: SSD Live Data

4.7.5. Prediction

This diagram shows the sequence operation between the User and the system that how user can view Predicted data on the system.

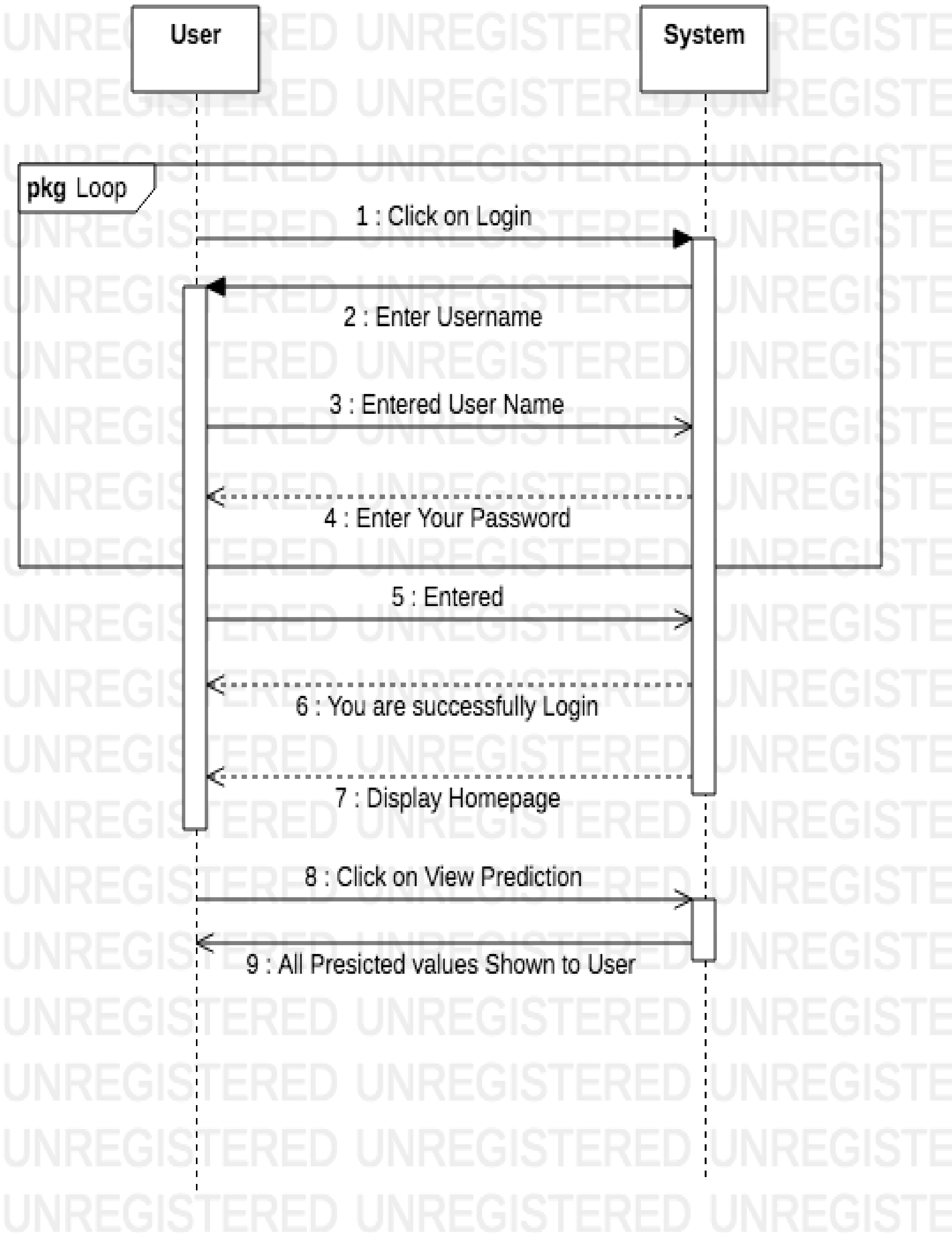

Figure 4.11: SSD Prediction

5. Implementation

5.1. User Interface

5.1.1. Application

5.1.1. Login User

These pictures show the welcome page of our website, shows where User can click to either login or register. *Figure 9.1* also is a part of a welcome page.

5.1.1.1. Login

The login screen where users can log in themselves is displayed in this image.

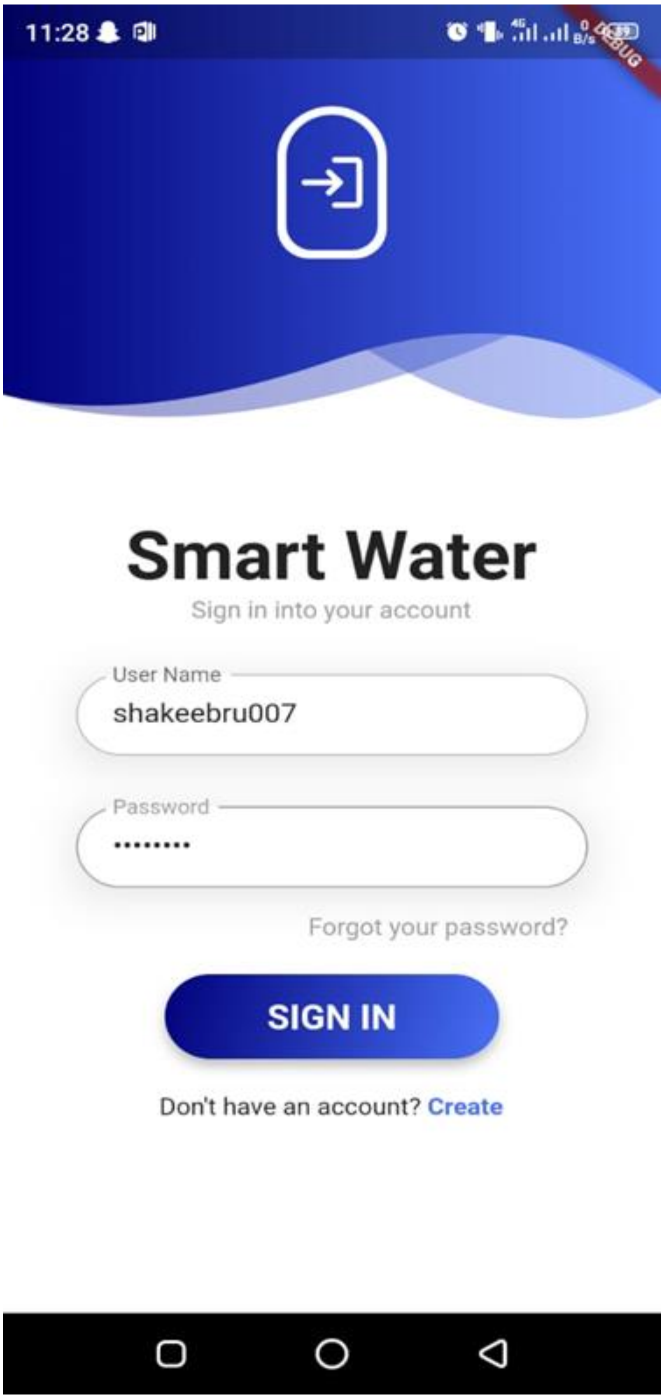

Figure 5.1: UI LOGIN

5.1.2. REGISTRATION USER

These pictures show the registration interface. Show the user register interface, shows the interface where user get register. the registration steps

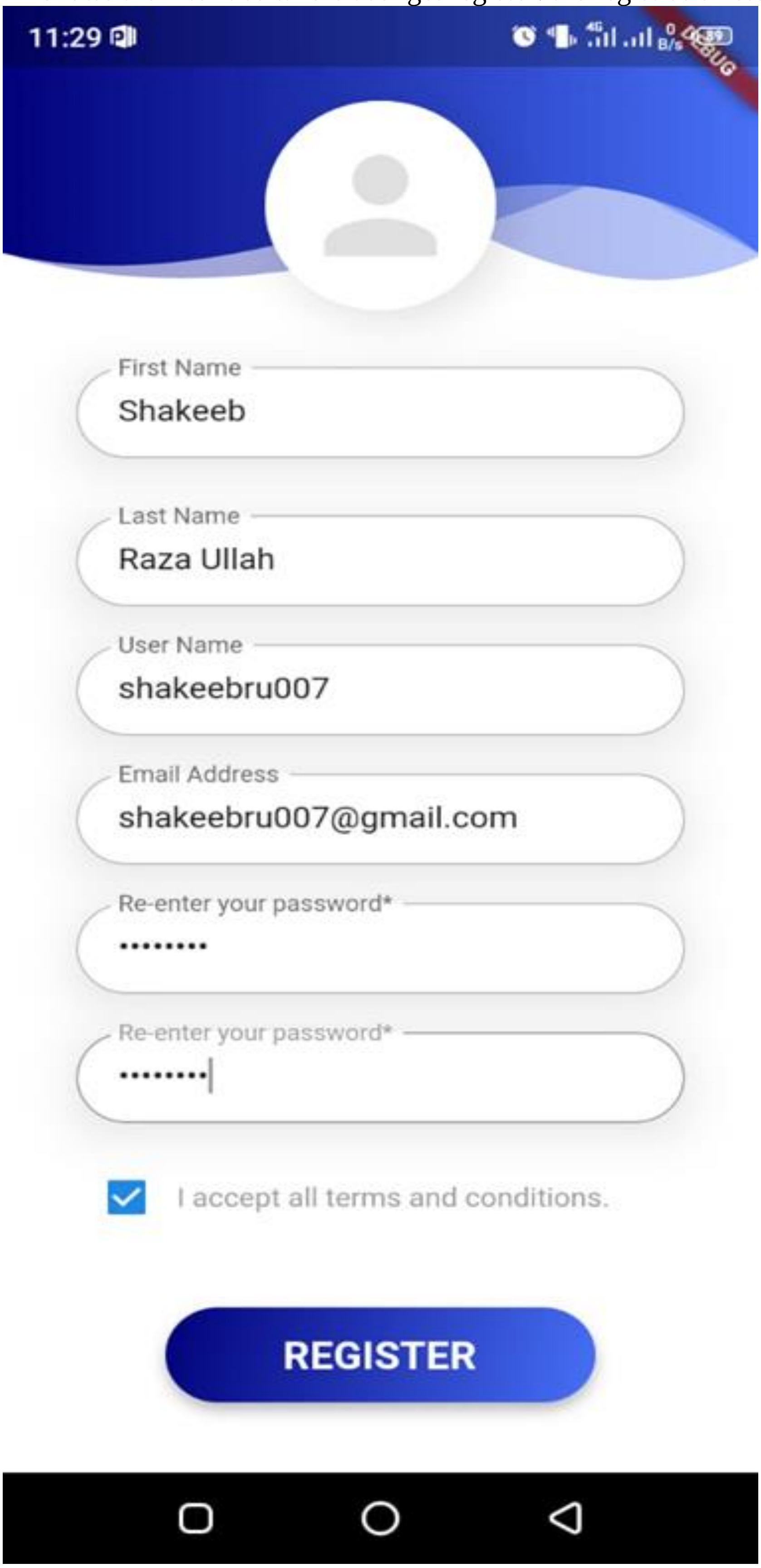

Figure 5.2: UI REGISTRATION USER

5.1.3. RESET PASSWORD

This picture shows the Reset Password where user can enter active email to get recovery code page.

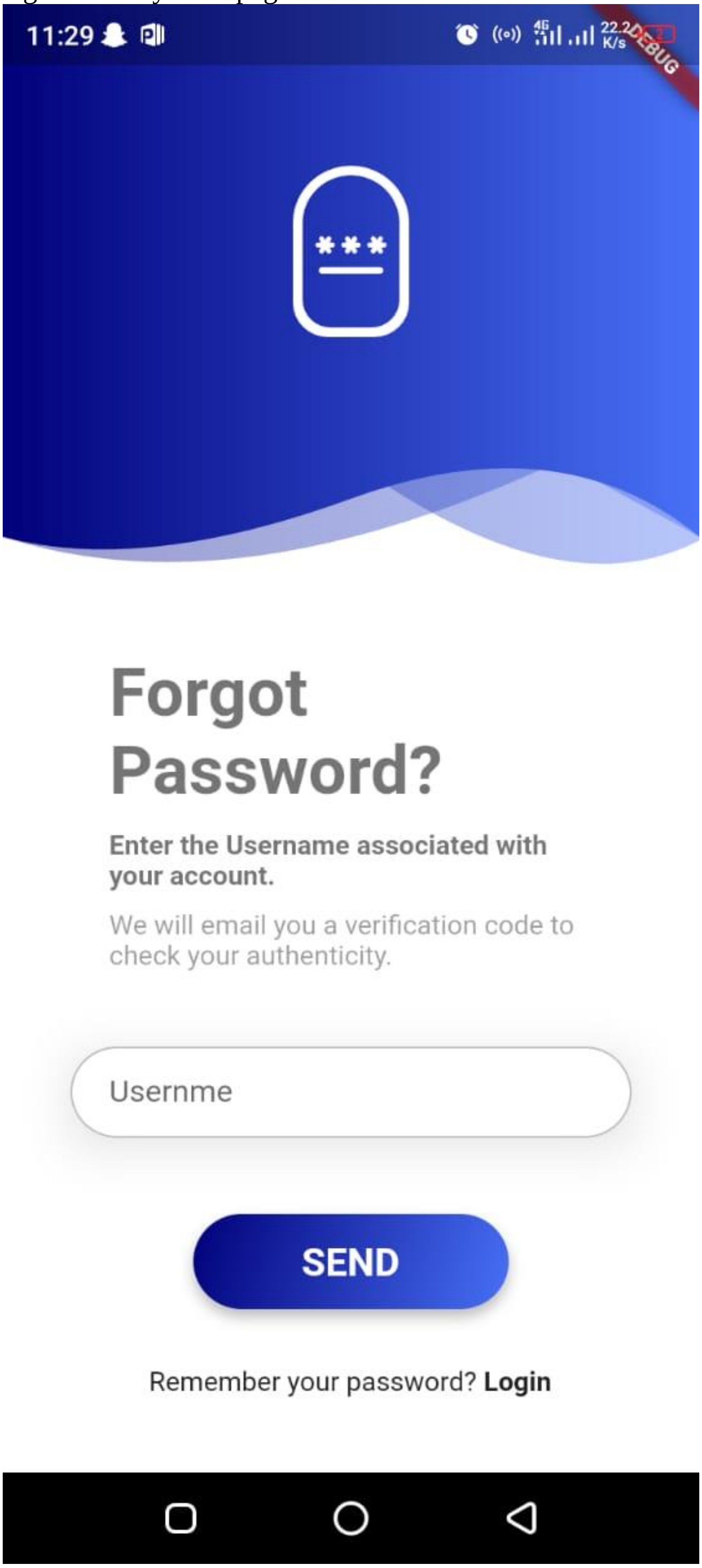

Figure 5.3: UI RESET PASSWORD

5.1.4. DASHBOARD (LIVE DATA)

This picture shows the User about the current condition of water that is the water is in drinkable condition or not.

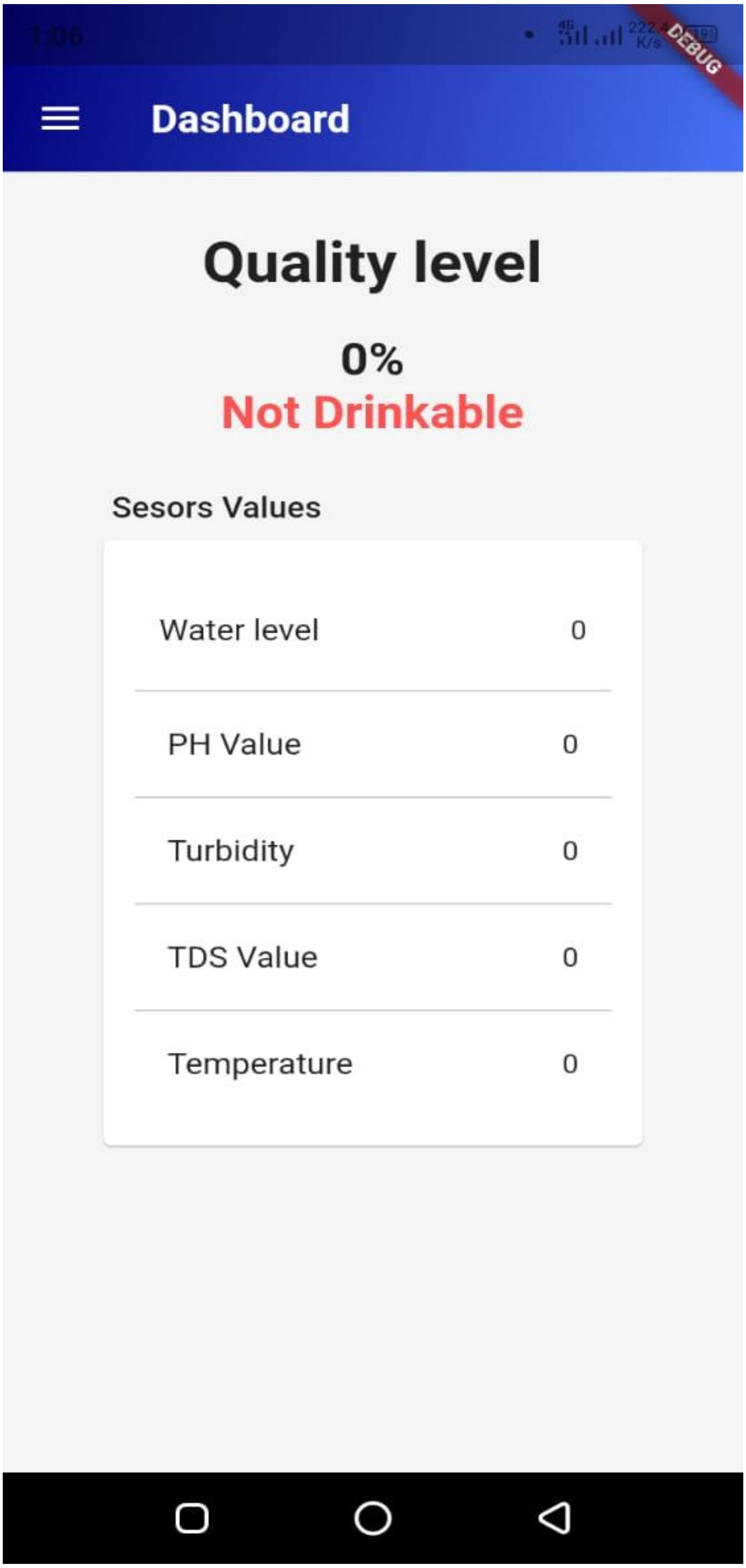

Figure 5.4: UI DASHBOARD (LIVE DATA)

5.1.4.1.Drinkable

In the condition as given in the figure below , The quality of water is 100% and drinkable.

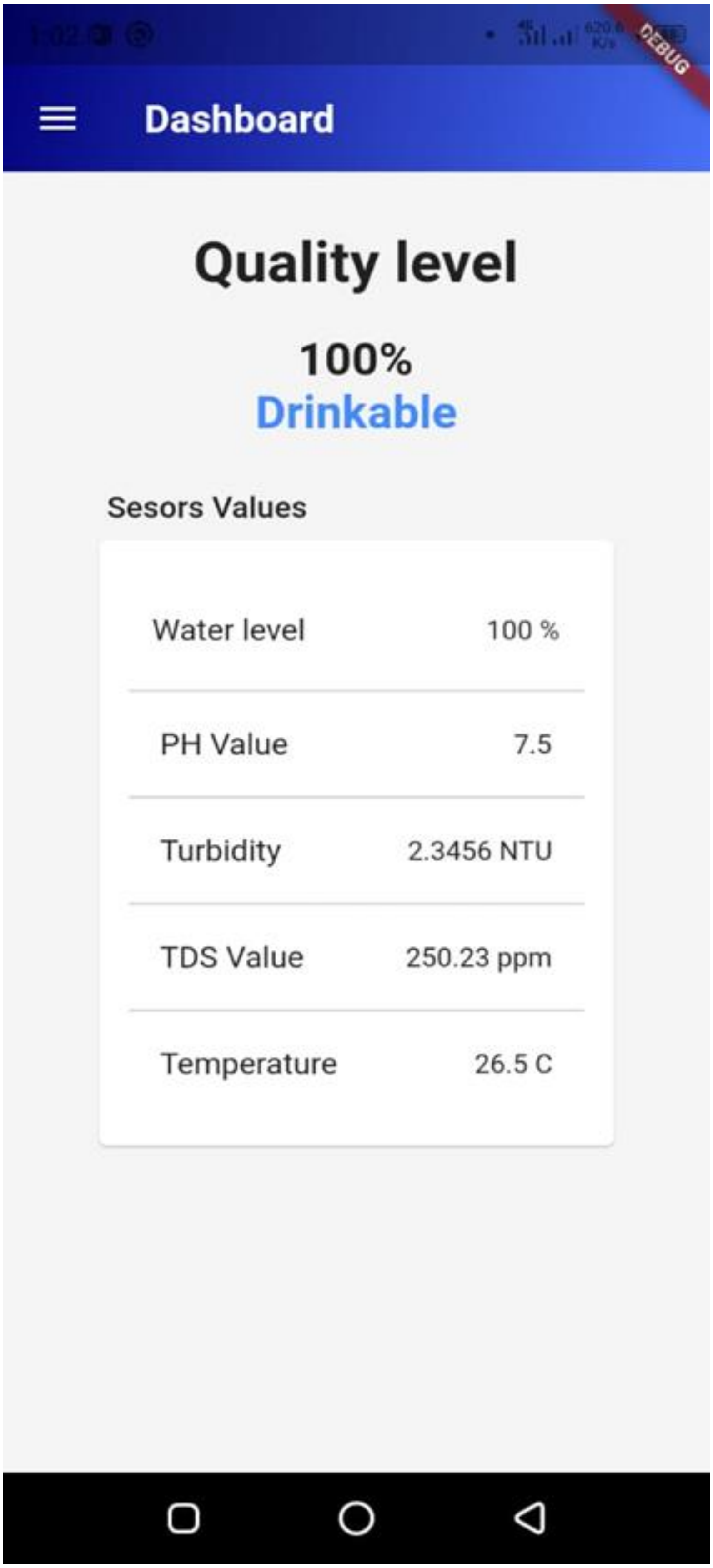

Figure 5.5: UI Drinkable

5.1.4.2. Not Drinkable

In the condition as given in the figure below , The quality of water is 50% and not drinkable.

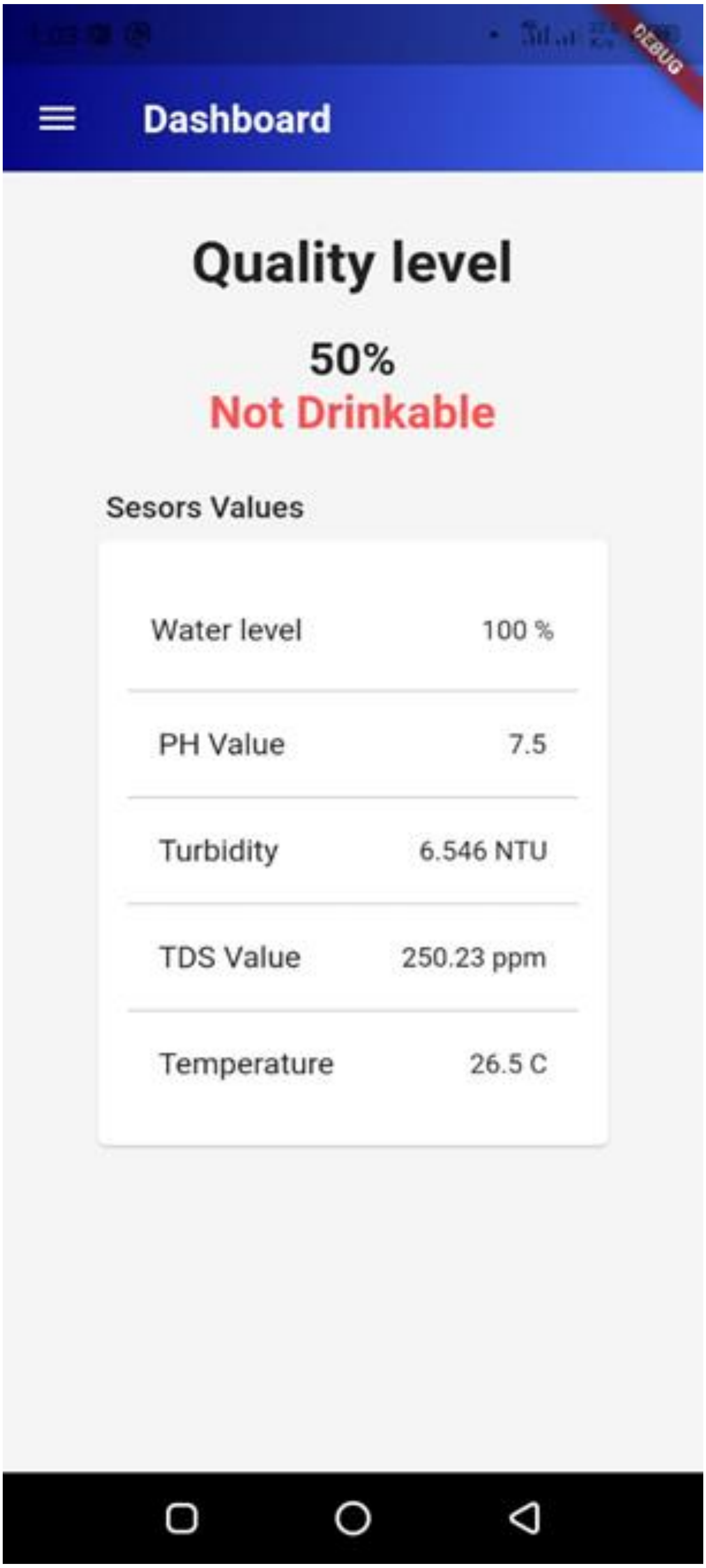

Figure 5.6: UI Not Drinkable

5.1.5. DASHBOARD MENU

This picture shows the login page from where Retailer and Distributor can login themselves.

Figure 5.7: UI DASHBOARD MENU

5.1.6. PASSWORD VERIFICATION

This picture shows the user to enter the recovery code which user gets through active email

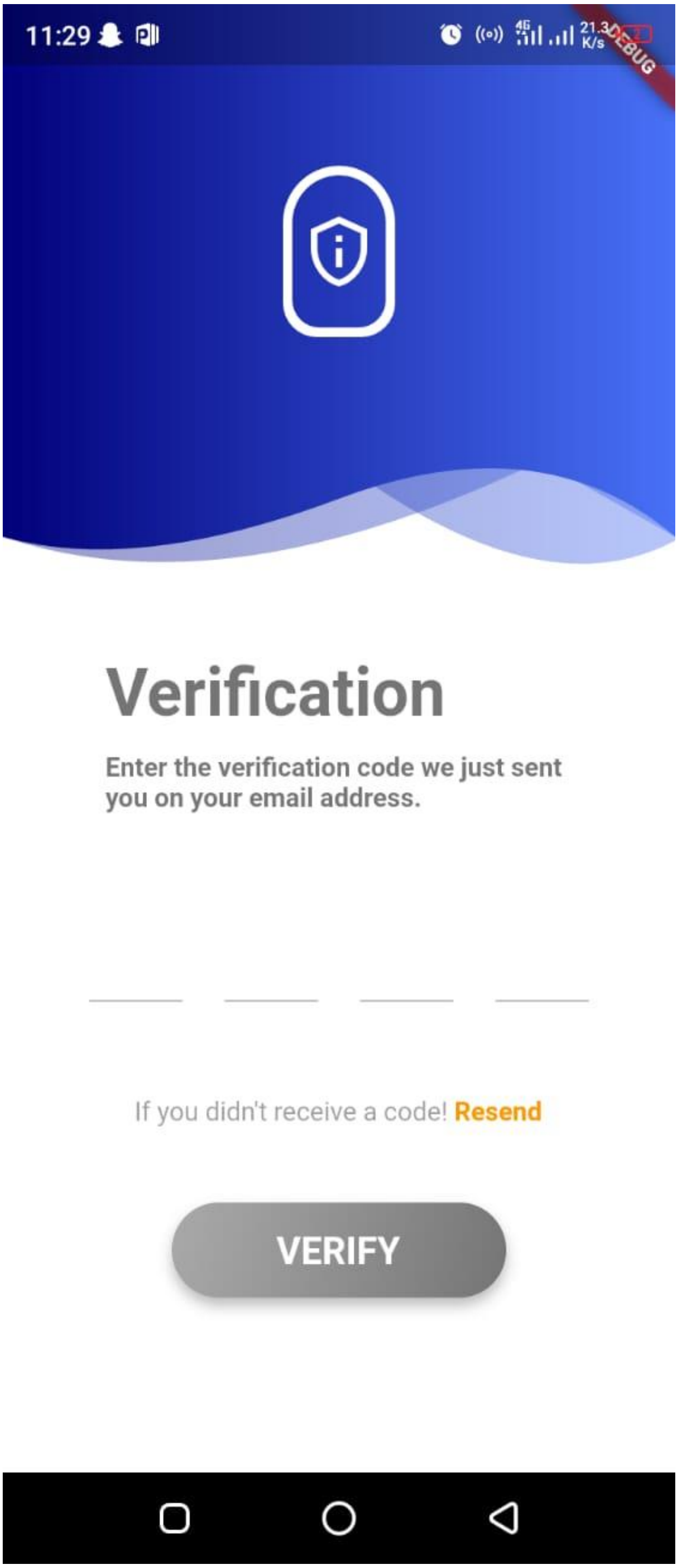

Figure 5.8: UI PASSWORD VERIFICATION

5.1.7. UI PREDICTION

This picture shows the Prediction the condition of water quality in upcoming days.

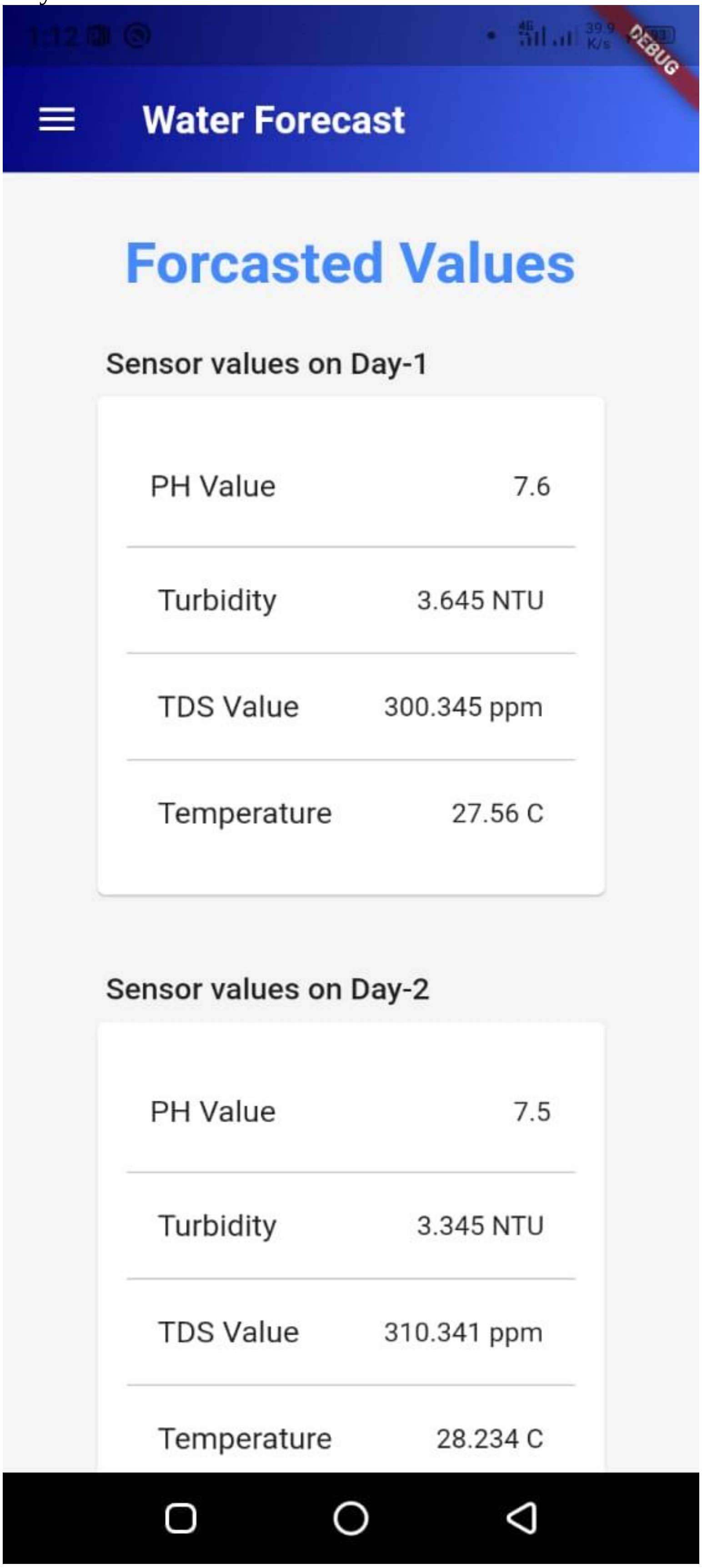

Figure 5.9: UI PREDICTION

6. Testing and Evaluation

This part includes automated and manual testing.

6.1. Manual Testing

To determine whether the Smart Water Quality System (SWQS) is functioning properly or if there is a problem with it, manual testing covers unit testing, system testing, functional testing, and integration testing.

6.1.1. System Testing

Smart Water Quality System (SWQS) is developed successfully with all the requirements written in requirement analysis section. Testing has been successfully performed to check the system, if it is working properly or not.

6.1.1.1. Login

Table 6.1: ST Login

Test Case Id	01	**Test Module**	Login
Wrote By	Developer Team	**Documented Date**	9/6/2022
Test Type	Manual	**Test Suite**	N/A
Product Name	SWQS	**Version**	V 1.0
Test Case Description		**Normal Flow**	**Expected Result**
1. The user fills out the form by entering their email and password. 2. Presses the Sign In button.		Successful system login by the user	User should be successfully logged into system"
Actor		User	
Precondition	1. The system ought to be off. 2. Tester Development Team Status PASS User should be registered		
Tester	Development Team	**Status**	PASS

6.1.1.2. Registration

Table 6.2: ST Registration

Test Case Id	02	**Test Module**	Registration
Wrote By	Developer Team	**Documented Date**	9/6/2022
Test Type	Manual	**Test Suite**	N/A
Product Name	SWQS	**Version**	V 1.0
Test Case Description		**Normal Flow**	**Expected Result**
1. The user selects the "Get yourself Registered" button in step 1. 2. The user supplies legitimate information in the user registration form. 3. The user selects "Register." 4. The user fills out the registration form completely. 5. The user selects "Register."		1. A fresh user account is made.	1. "A fresh account should be created."
Actor		User	
Precondition	1. System should be idle		
Tester	Development Team	**Status**	PASS

6.1.1.3. Live Readings

Table 6.3: ST Live Readings

Test Case Id	03	**Test Module**	Live Readings
Wrote By	Developer Team	**Documented Date**	9/6/2022
Test Type	Manual	**Test Suite**	N/A
Product Name	SWQS	**Version**	V 1.0
Test Case Description		**Normal Flow**	**Expected Result**
1. Live readings are accessible on the dashboard. 2. An app can access real-time sensor data.		1. Sensors are functional 2. sensors provide accurate data	1.Sensors should function properly.
Actor		System	
Precondition	1. System should be perfect workable condition 2. User should be registered as User		
Tester	Development Team	**Status**	PASS

6.1.1.4. Prediction

Table 6.4: ST Prediction

Test Case Id	03	**Test Module**	Predicted data
Wrote By	Developer Team	**Documented Date**	9/6/2022
Test Type	Manual	**Test Suite**	N/A
Product Name	SWQS	**Version**	V 1.0
Test Case Description		**Normal Flow**	**Expected Result**
1. User clicks on “prediction” button 2. Water forecasting shown to the user.		1. Live data can properly store in firebase	1. Live data should be properly stored in firebase 2. ML algos should be applied to data Properly
Actor		System	
Precondition	1. System should be idle. 2. Medicine should be available in online store. 3. Retailer should be registered and subscribed. 4. Distributor should be registered and subscribed		
Tester	Development Team	**Status**	PASS

6.1.2. Unit Testing

6.1.2.1. Login User

Table 6.5: UT Login User

No.	Objective	Input Data	Expected Result	Result
1	User "SIGN IN"	Email: shanzay_kamran Password: xyz	Successfully login to the relevant Dashboard page.	Pass
	Verifies Retailer or Distributor credentials after	Email: shanzay Password: vgy	"Invalid Email or Password"	Pass

6.1.2.2. Registration User

Table 6.6: UT Registration

No.	Objective	Input Data	Expected Result	Result
3	User enters the required credentials correctly and press "Register" button.	First Name: shanzay Last name: kamran Email: shanzay.kamran9000@gmail.com Password :xyz Re-enter Password: xyz	Successfully shows the dashboard.	Pass
	User enters any of the required credentials incorrectly and press "Register" button.	First Name: shanzay Last name: - Email: shanzay.kamran9000@gmail.com Password: xyz Re-enter Password: bbb	"Enter the proper credentials after reading the help box and enter correct password."	Pass

6.1.3. Integration Testing

Table 6.7: Integration Testing

IT No	Test Case	Attribute and Value	Expected Result	Status
1.	Login as User	Enter valid name/email/Password	User Login Successfully	Pass
2.	User Registration	Enter all credentials and active email	User Registered Successfully	Pass
3.	Reset Password	Enter Correct active email	Successfully get recovery Code	Pass
4.	Live data	Sensors must Be give accurate readings	User can view Live Readings	Pass
5.	Monitoring	Predicted value	User is successfully able to see Upcoming water condition	Pass

7. Conclusion and Future Work

7.1. Conclusion

Monitoring turbidity, PH, TDS, water flow, and water temperature makes excellent use of a water detection sensor with a distinct benefit. The data acquired by these sensors will be sent to Arduino, where machine learning will be used to predict the data and it will be shown on a mobile application. The system is low-cost, can monitor water quality automatically, and doesn't need staff to be on duty. Water quality monitoring consequently becomes more accessible, practical, and efficient.t also offers a lot of flexibility. Monitoring water quality in the twenty-first century is an increasing concern, and our project may be customized to meet the needs of the future. As it becomes more difficult to maintain a clean, green environment, making water free of all contaminants can have a significant positive impact in these surroundings.

7.2. Future Work

This system may be utilized to monitor various water quality parameters on any greater scale simply by replacing the associated sensors and altering the related software applications. The system can be developed to track industrial and agricultural productivity, as well as aquatic life.

8. References

The references sites used for a helping purpose for this project on every phase of the project are:

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5. [3] H. Wu, Y. Guo, L. Xiong, W. Liu, G. Li, and X. J. I. S. J. Zhou, "Optical fiber-based sensing, measuring, and implementation methods for slope deformation monitoring: a review," vol. 19, no. 8, pp. 2786-2800, 2019.